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Basu et al.

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[45] **Date of Patent: Aug. 1, 2000**

[54] **SYSTEM AND ASSOCIATED METHOD OF OPERATION FOR MANAGING BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM SUPPORTING MULTIMEDIA COMMUNICATIONS**

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[21] Appl. No.: **08/876,192**

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[51] **Int. Cl.**[7] **H04Q 7/34**

[52] **U.S. Cl.** **370/468**; 370/329; 370/338; 370/341; 370/521; 455/452; 455/561; 455/560

[58] **Field of Search** 370/328, 329, 370/341, 465, 468, 521, 335, 336, 337, 338, 342, 345, 347, 441, 442, 437, 474, 479, 477; 455/422, 450, 452, 507, 509, 517, 550, 560, 561

[56] **References Cited**

U.S. PATENT DOCUMENTS

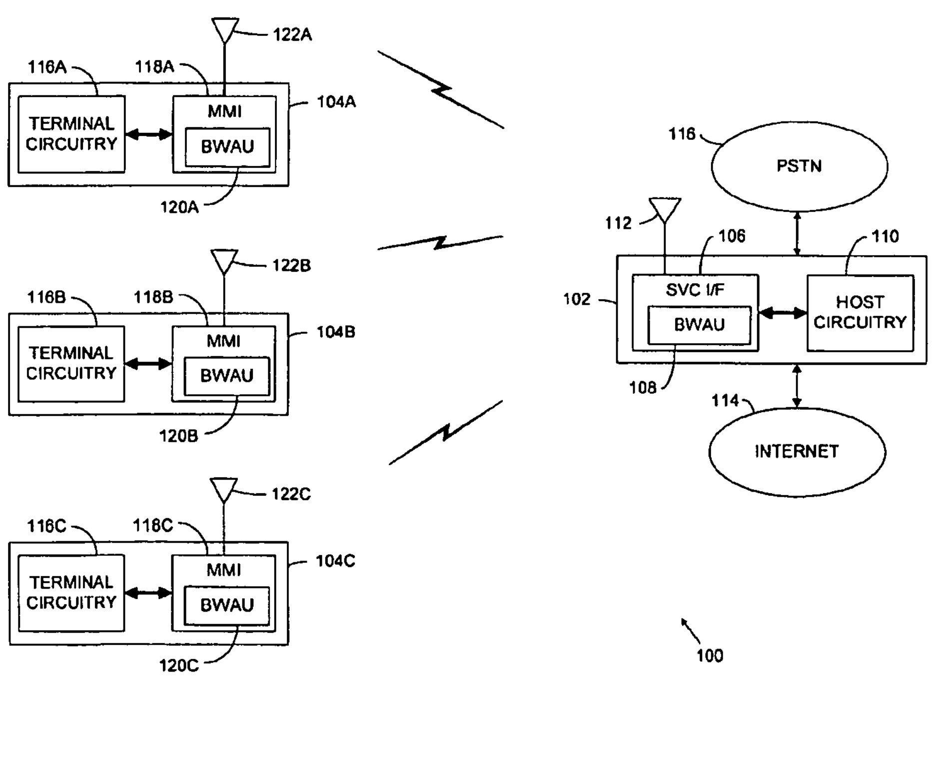
5,590,127	12/1996	Bales et al.	370/468
5,613,198	3/1997	Ahmadi et al.	370/648
5,625,877	4/1997	Dunn et al.	370/329
5,751,712	5/1998	Farwell et al.	370/468
5,818,830	10/1998	Daane et al.	370/347
5,914,945	6/1999	Abu-Amara et al.	370/329

Primary Examiner—Ricky Ngo
Attorney, Agent, or Firm—Bruce Garlick

[57] **ABSTRACT**

A communication system provides wireless voice and multimedia communications and includes a base station, a plurality of wireless mobile units and a bandwidth allocator. The base station provides wireless coverage throughout a service area and has a bandwidth for providing the wireless coverage. The plurality of wireless mobile units operate within the service area and communicate with the base station to transmit and receive both voice communications and multimedia communications. The bandwidth allocator selectively allocates the bandwidth in response to wireless multimedia communication requirements to achieve a minimum transmission rate for multimedia communications. The communication system may include a plurality of channels, each having a channel bandwidth with the bandwidth allocator selectively allocating the channels in response to the multimedia communication requirements to achieve the minimum transmission rate. The base station may also include a plurality of data modems, each of the data modems providing a respective portion of the bandwidth, the bandwidth allocator selectively allocating the plurality of data modems of the base station to achieve the minimum transmission rate. Further, at least one of the wireless mobile units may include a plurality of data modems with the bandwidth allocator selectively allocating the data modems of the wireless mobile unit to achieve the minimum transmission rate. In such case, each of the of the plurality of modems may be assigned a channel. In some constructions, the bandwidth allocator may allocate time divisions of the plurality of channels bandwidth while in other constructions may allocate allocating code divisions of the bandwidth to achieve the minimum transmission rate.

36 Claims, 10 Drawing Sheets



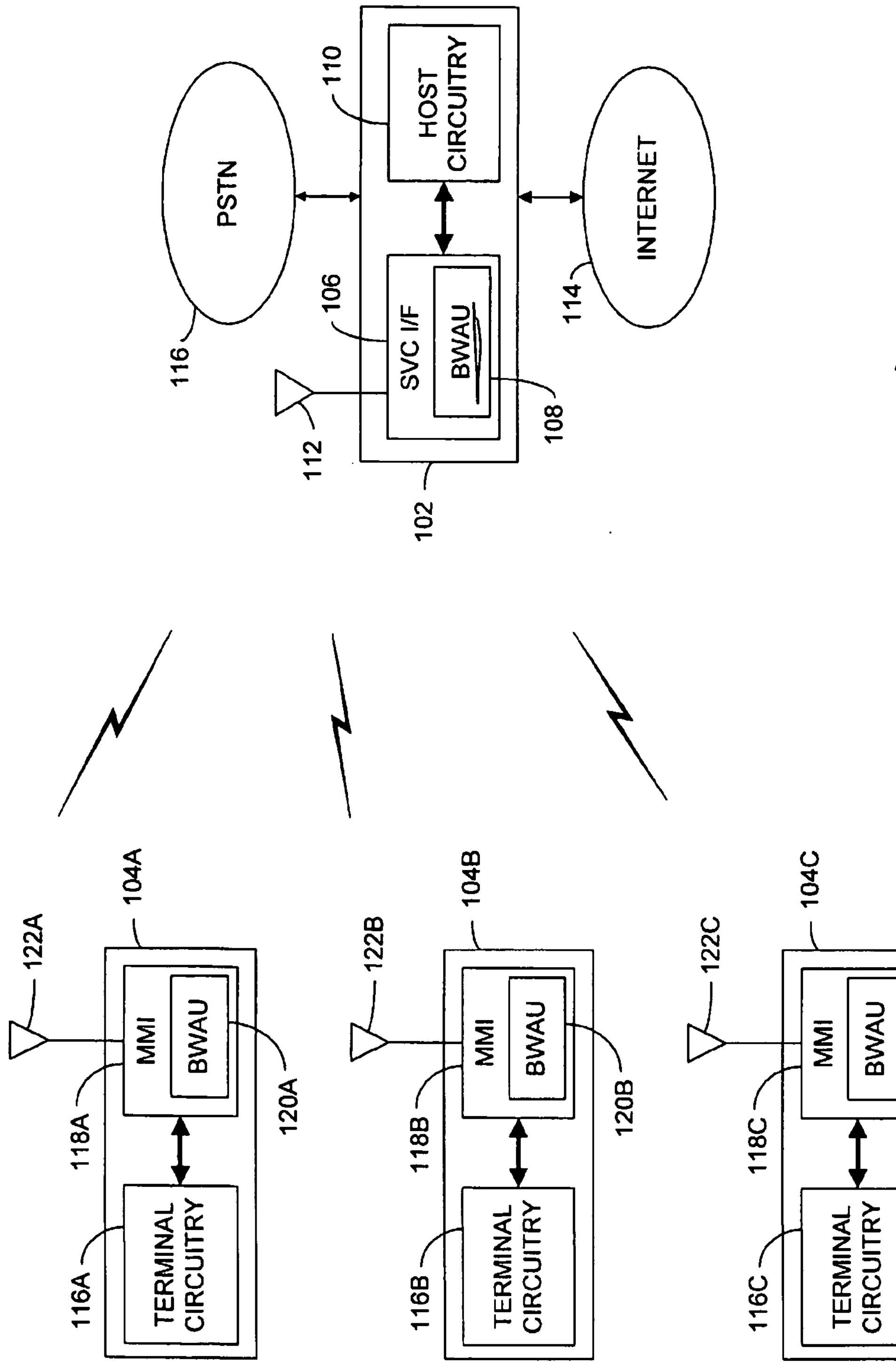
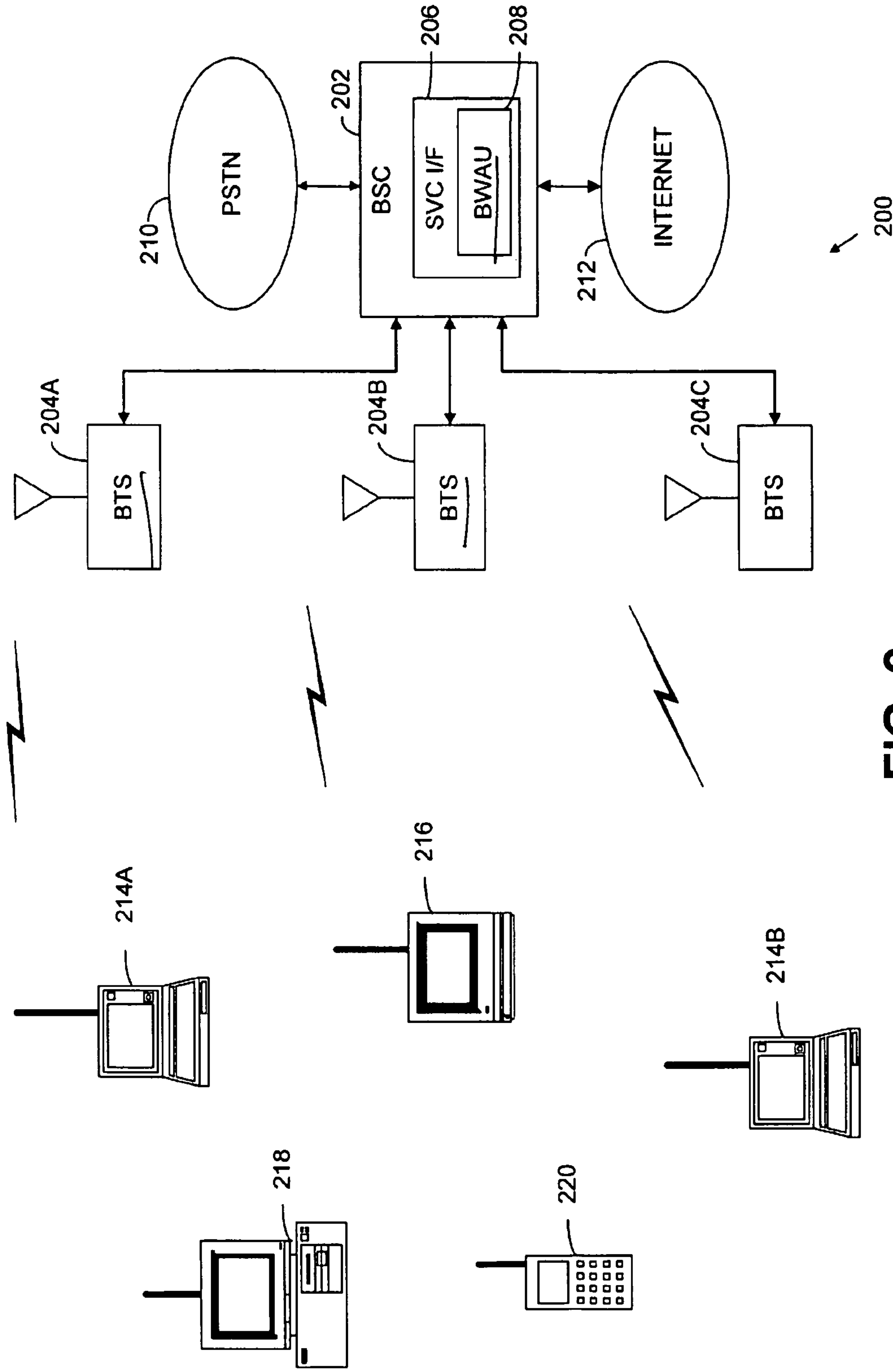

PSTN
HOST CIRCUITRY
SVC I/F
BWAU
INTERNET
MMI
TERMINAL CIRCUITRY
100
102
104A
104B
104C
106
108
110
112
114
116
116A
116B
116C
118A
118B
118C
120A
120B
120C
122A
122B
122C

FIG. 1



200
202
BSC
206
SVC I/F
208
BWAU
210
PSTN
212
INTERNET
204A
BTS
204B
BTS
204C
BTS
214A
216
214B
218
220

FIG. 2

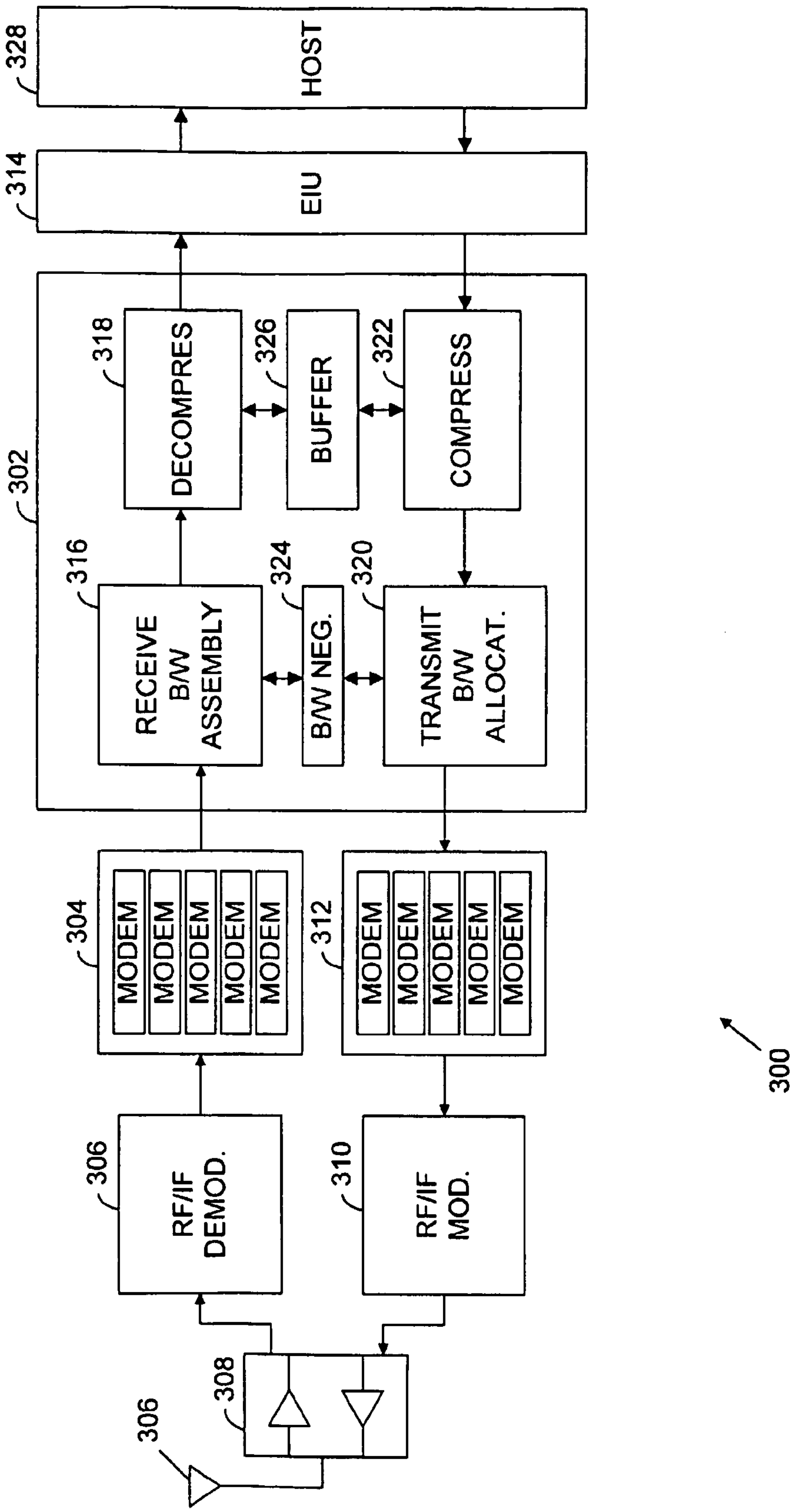

328
HOST
314
EIU
302
318
DECOMPRES
326
BUFFER
322
COMPRESS
316
RECEIVE
B/W
ASSEMBLY
324
B/W NEG.
320
TRANSMIT
B/W
ALLOCAT.
304
MODEM
MODEM
MODEM
MODEM
MODEM
312
MODEM
MODEM
MODEM
MODEM
MODEM
306
RF/IF
DEMOD.
310
RF/IF
MOD.
308
306
300

FIG. 3

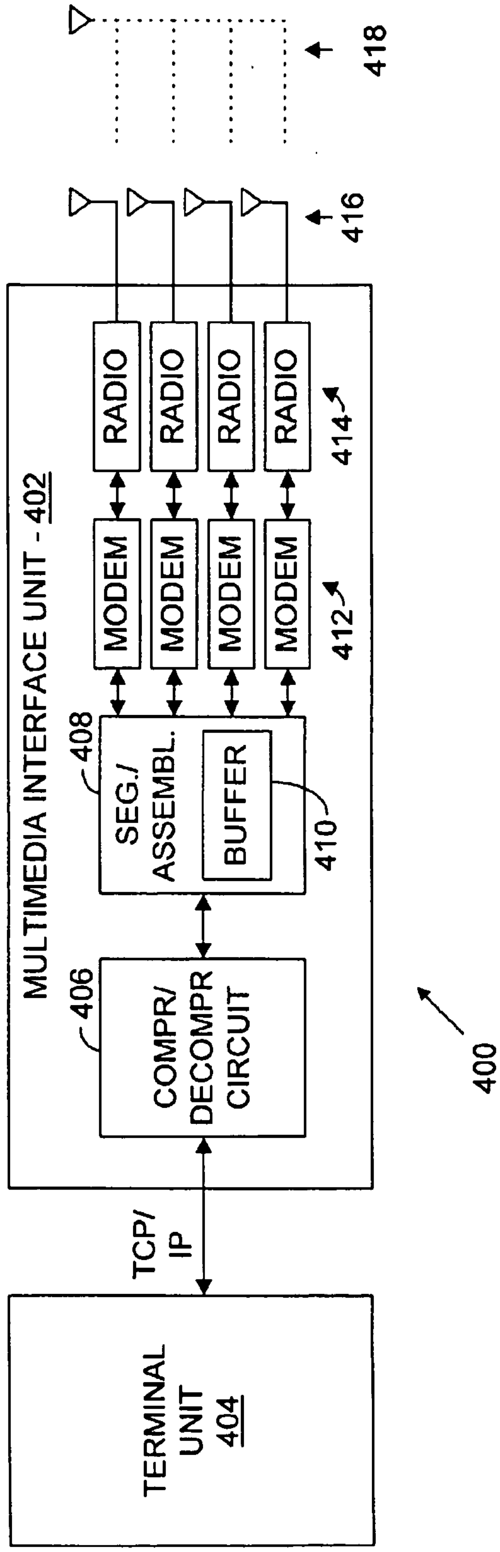

418
416
MULTIMEDIA INTERFACE UNIT - 402
RADIO
RADIO
RADIO
RADIO
414
MODEM
MODEM
MODEM
MODEM
412
408
SEG./ ASSEMBL.
BUFFER
410
406
COMPR/ DECOMPR CIRCUIT
400
TCP/ IP
TERMINAL UNIT 404

FIG. 4A

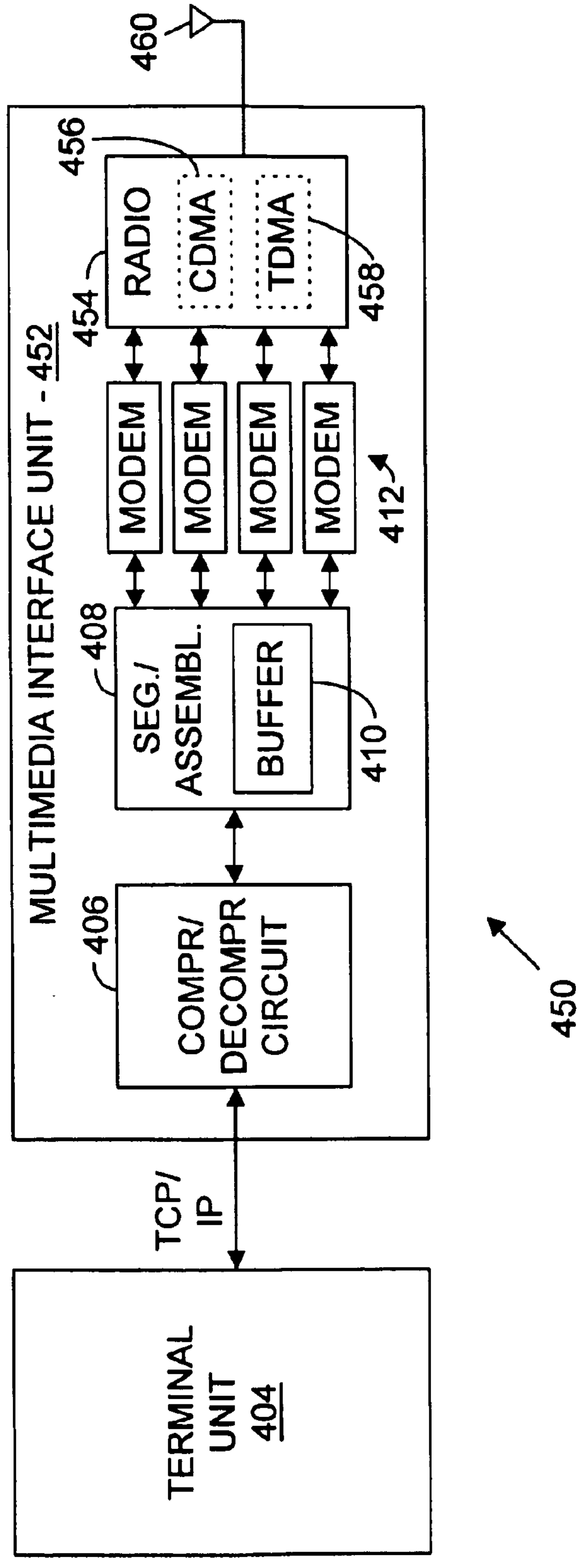

460
456
RADIO
CDMA
TDMA
454
458
MULTIMEDIA INTERFACE UNIT - 452
MODEM
MODEM
MODEM
MODEM
412
408
SEG./
ASSEMBL.
BUFFER
410
406
COMPR/
DECOMPR
CIRCUIT
450
TCP/
IP
TERMINAL
UNIT
404

FIG. 4B

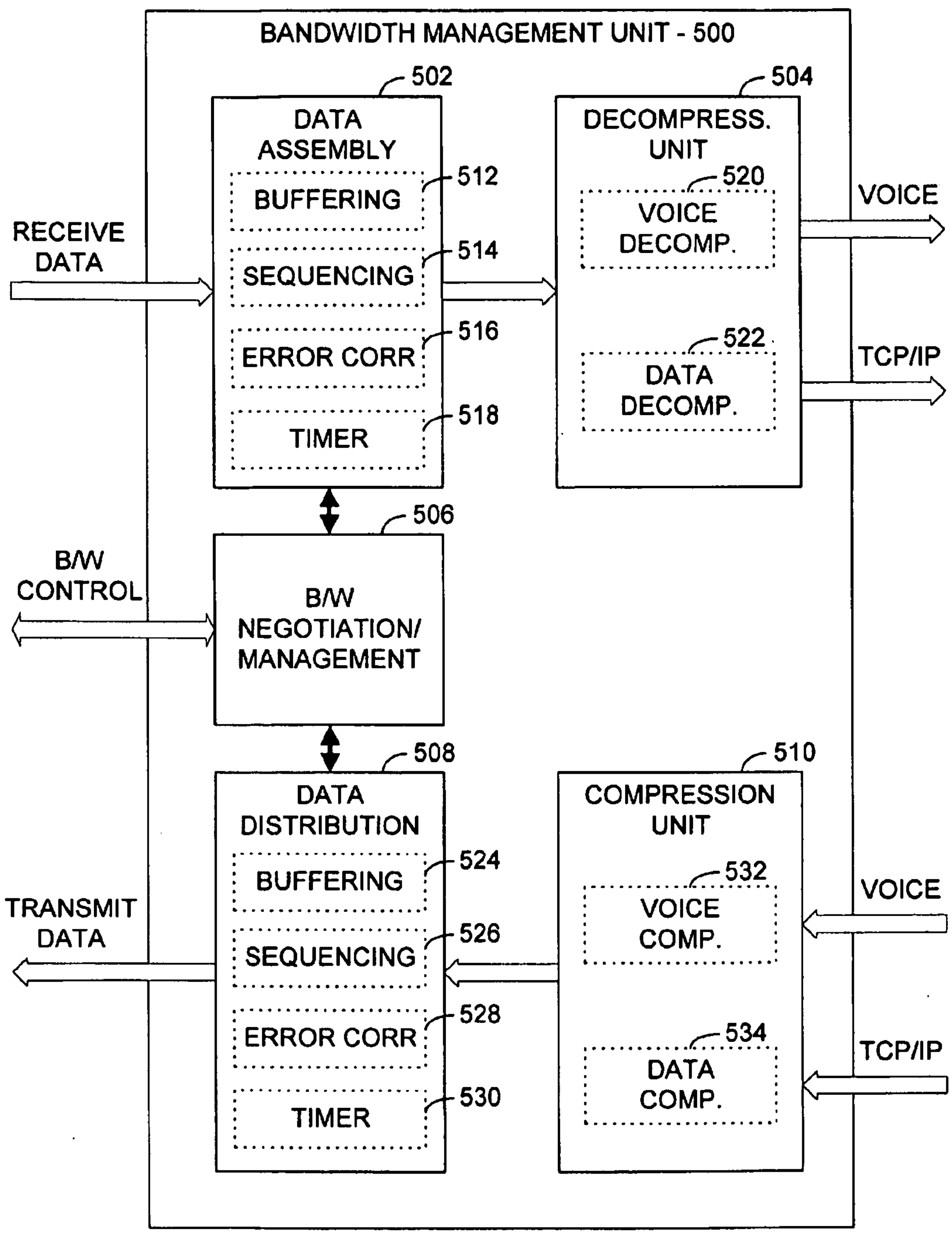

BANDWIDTH MANAGEMENT UNIT - 500
502
DATA ASSEMBLY
BUFFERING
512
SEQUENCING
514
ERROR CORR
516
TIMER
518
504
DECOMPRESS. UNIT
520
VOICE DECOMP.
522
DATA DECOMP.
VOICE
TCP/IP
RECEIVE DATA
506
B/W CONTROL
B/W NEGOTIATION/ MANAGEMENT
508
DATA DISTRIBUTION
BUFFERING
524
SEQUENCING
526
ERROR CORR
528
TIMER
530
510
COMPRESSION UNIT
532
VOICE COMP.
534
DATA COMP.
VOICE
TCP/IP
TRANSMIT DATA

FIG. 5

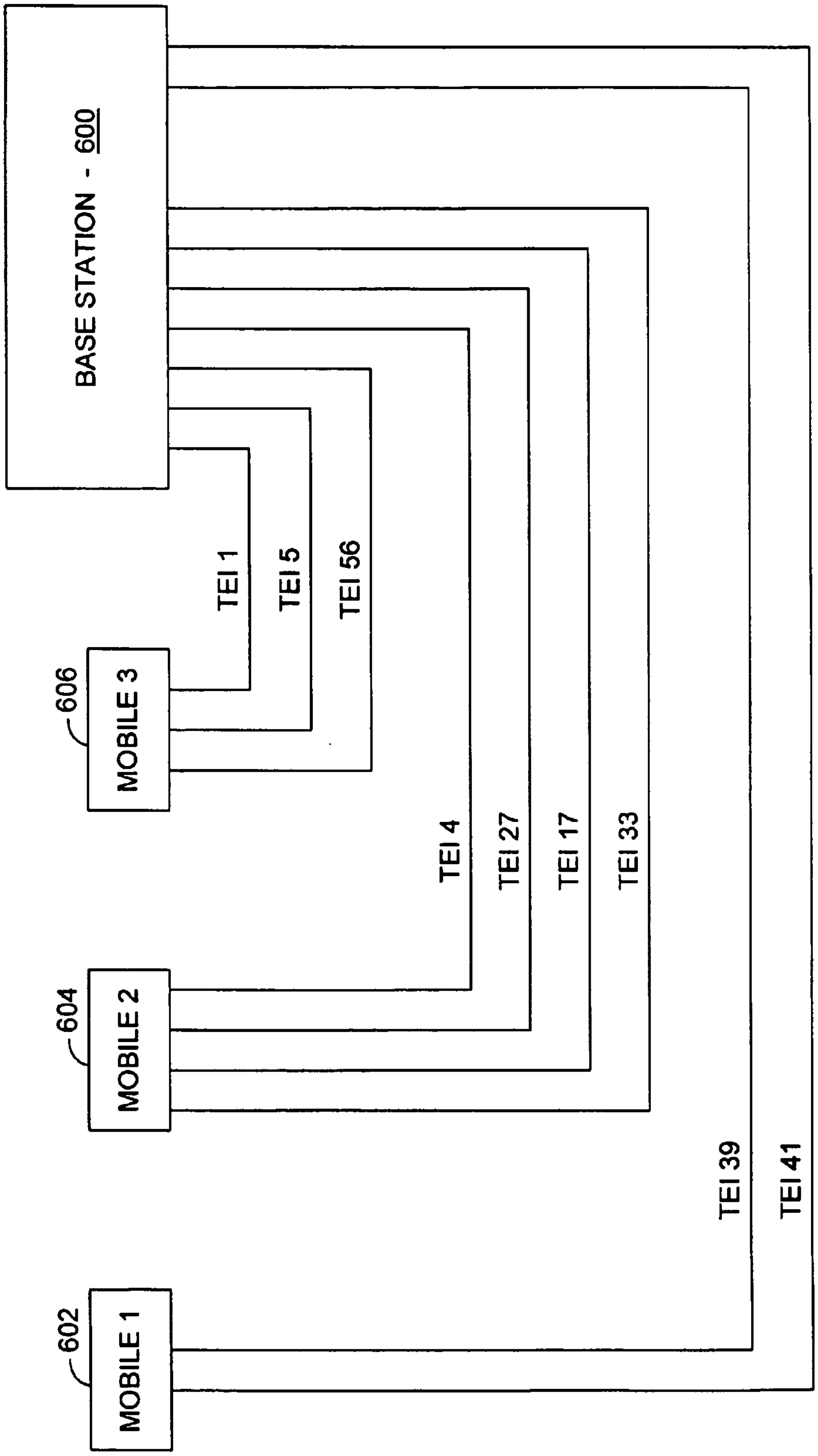

BASE STATION - 600
MOBILE 3
606
MOBILE 2
604
MOBILE 1
602
TEI 1
TEI 5
TEI 56
TEI 4
TEI 27
TEI 17
TEI 33
TEI 39
TEI 41
600

FIG. 6

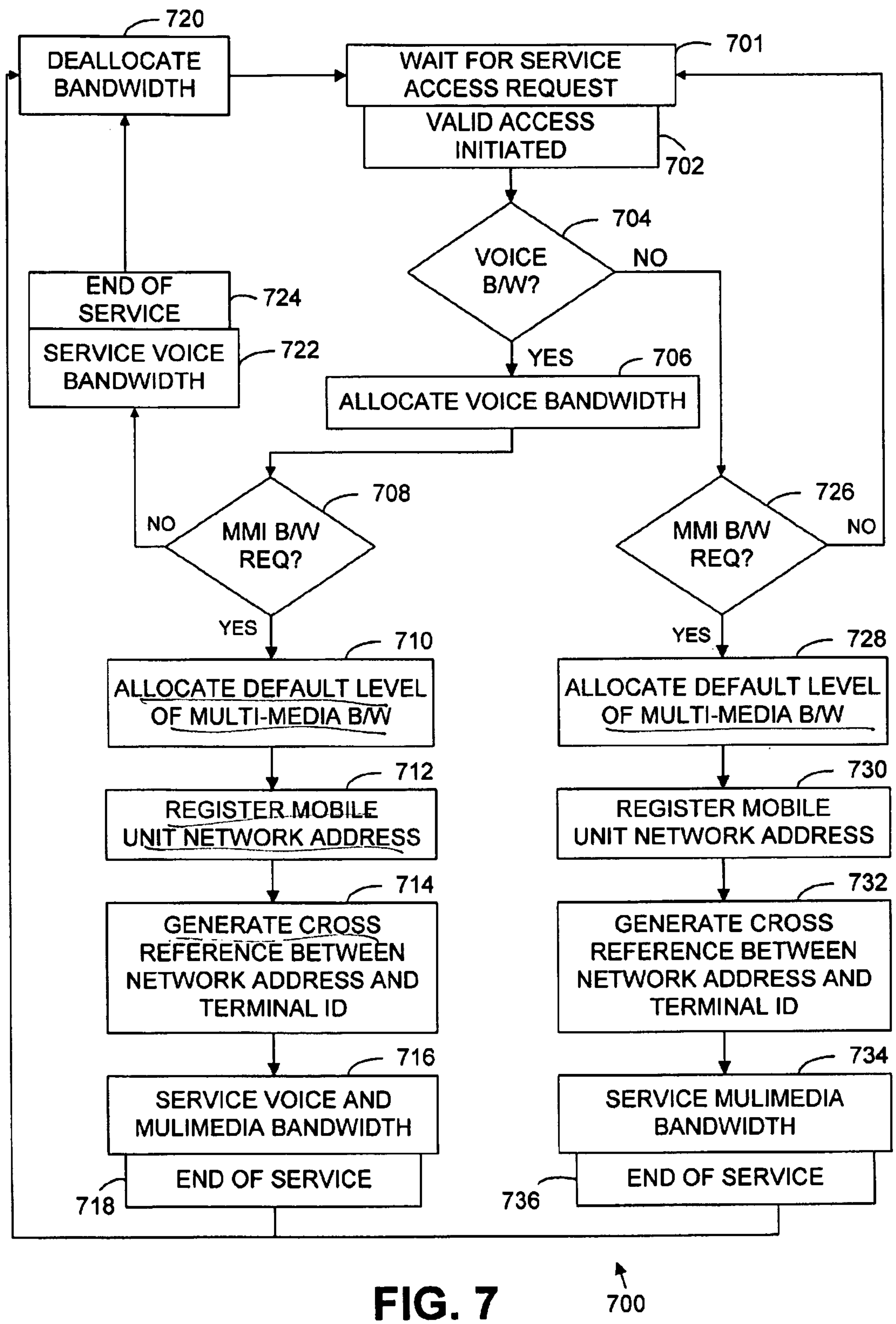

720
DEALLOCATE BANDWIDTH
WAIT FOR SERVICE ACCESS REQUEST
701
VALID ACCESS INITIATED
702
704
VOICE B/W?
NO
END OF SERVICE
724
SERVICE VOICE BANDWIDTH
722
YES
706
ALLOCATE VOICE BANDWIDTH
708
MMI B/W REQ?
NO
726
MMI B/W REQ?
NO
YES
710
ALLOCATE DEFAULT LEVEL OF MULTI-MEDIA B/W
YES
728
ALLOCATE DEFAULT LEVEL OF MULTI-MEDIA B/W
712
REGISTER MOBILE UNIT NETWORK ADDRESS
730
REGISTER MOBILE UNIT NETWORK ADDRESS
714
GENERATE CROSS REFERENCE BETWEEN NETWORK ADDRESS AND TERMINAL ID
732
GENERATE CROSS REFERENCE BETWEEN NETWORK ADDRESS AND TERMINAL ID
716
SERVICE VOICE AND MULIMEDIA BANDWIDTH
734
SERVICE MULIMEDIA BANDWIDTH
END OF SERVICE
718
END OF SERVICE
736
700

FIG. 7

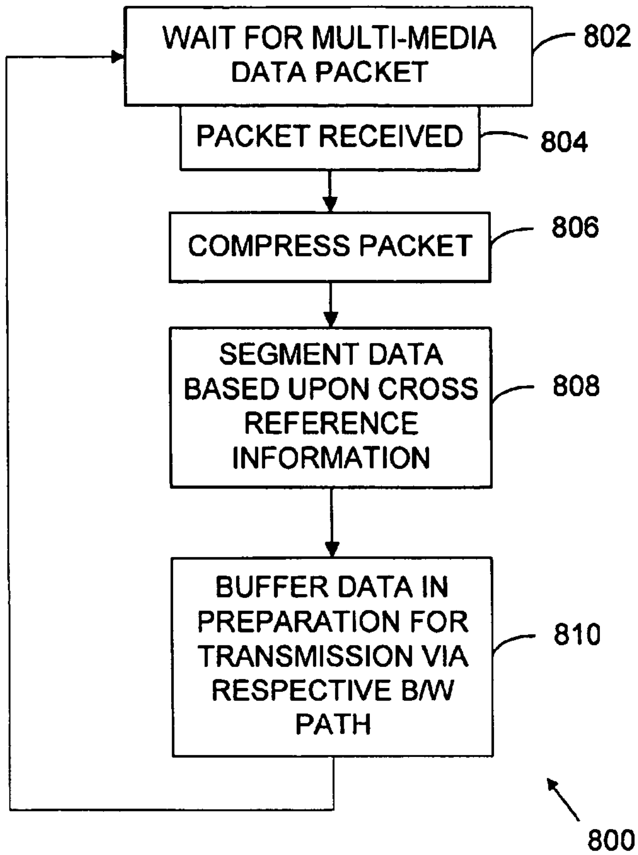

WAIT FOR MULTI-MEDIA DATA PACKET
802
PACKET RECEIVED
804
COMPRESS PACKET
806
SEGMENT DATA BASED UPON CROSS REFERENCE INFORMATION
808
BUFFER DATA IN PREPARATION FOR TRANSMISSION VIA RESPECTIVE B/W PATH
810
800

FIG. 8A

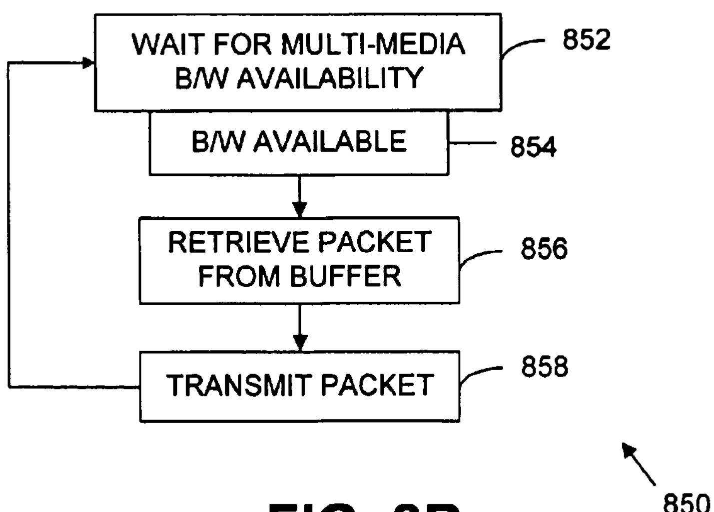

WAIT FOR MULTI-MEDIA B/W AVAILABILITY
852
B/W AVAILABLE
854
RETRIEVE PACKET FROM BUFFER
856
TRANSMIT PACKET
858
850

FIG. 8B

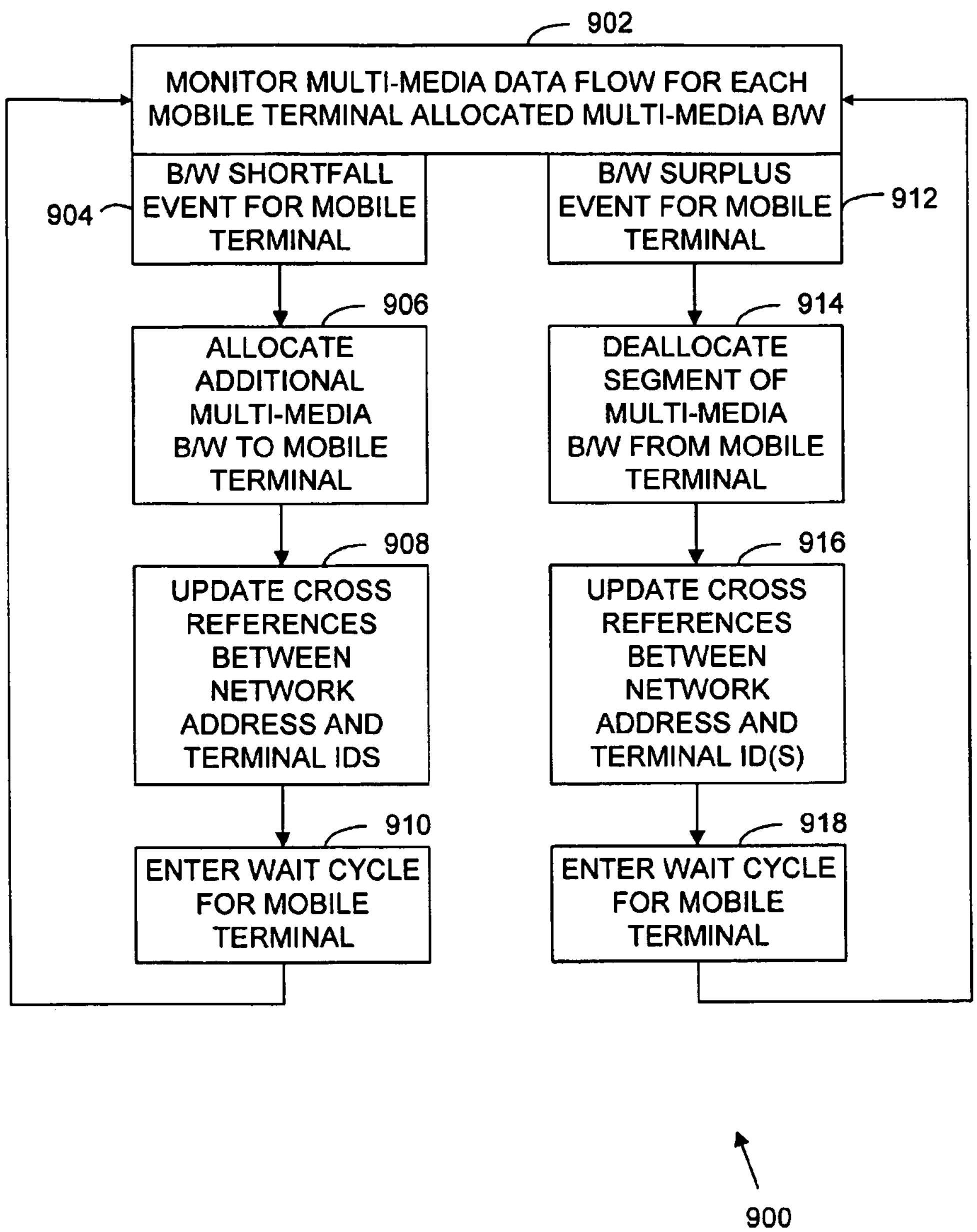

902
MONITOR MULTI-MEDIA DATA FLOW FOR EACH MOBILE TERMINAL ALLOCATED MULTI-MEDIA B/W
904
B/W SHORTFALL EVENT FOR MOBILE TERMINAL
906
ALLOCATE ADDITIONAL MULTI-MEDIA B/W TO MOBILE TERMINAL
908
UPDATE CROSS REFERENCES BETWEEN NETWORK ADDRESS AND TERMINAL IDS
910
ENTER WAIT CYCLE FOR MOBILE TERMINAL
912
B/W SURPLUS EVENT FOR MOBILE TERMINAL
914
DEALLOCATE SEGMENT OF MULTI-MEDIA B/W FROM MOBILE TERMINAL
916
UPDATE CROSS REFERENCES BETWEEN NETWORK ADDRESS AND TERMINAL ID(S)
918
ENTER WAIT CYCLE FOR MOBILE TERMINAL
900

FIG. 9

SYSTEM AND ASSOCIATED METHOD OF OPERATION FOR MANAGING BANDWIDTH IN A WIRELESS COMMUNICATION SYSTEM SUPPORTING MULTIMEDIA COMMUNICATIONS

BACKGROUND

1. Technical Field

This present invention relates generally to communication systems and more particularly to a system and associated method of operation for managing bandwidth available within a wireless communication system to apportion the bandwidth among various multimedia data transmission and voice transmission operations to achieve desired bandwidth performance for the operations.

2. Related Art

Both wired and wireless communication systems are well known. As such communication systems have developed, the systems have proceeded from supporting merely voice communications to supporting other types of information as well. Information commonly communicated in such communication systems now includes, besides voice communications, encoded audio data such as music, encoded video information, facsimile transmissions and formatted file data, among other types of information. Cumulatively, such information in various formats is referred to as multimedia information.

Various standards currently exist for wireless communication systems. The Advanced Mobile Phone System (AMPS) has facilitated wireless cellular communications within the United States for years. As technology has advanced other standards have also been developed and implemented throughout the world to provide wireless communications. The Narrowband Advanced Mobile Phone Service (NAMPS) standard, the Global Standard for Mobility (GSM) standard and the Code Division Multiple Access (CDMA) standard, for example, are currently employed to provide wireless communication.

Over the years, the demands placed upon wireless communication systems have increased as well. Such demands originally increased due to greater user traffic within the wireless communication systems. However, with the advent of multimedia communications, additional bandwidth is now required for the transfer of multimedia information. As compared to the requirements for analog voice transmissions, these requirements are great.

For example, analog wireless voice communication systems may require as little as eight kilohertz of bandwidth for analog voice transmissions, or less. However, multimedia communications typically require much greater bandwidth. The standard bandwidth required for digitized packet data transmission for Internet applications typically is, at a minimum, 14.4 kilobits per second (KBPS). Shortly, 33.3 KBPS of bandwidth will be required for standard Internet applications. Heretofore, such bandwidth was achievable only through the use of a wired connection in a wired communication system. Wired modems, operating between 14.4 to 33.3 KBPS, generally provided sufficient bandwidth for most Internet users. Alternatively, Integrated Services Digital Network (ISDN) lines used in conjunction with ISDN modems provided relatively greater bandwidth for users. However, such bandwidths were only obtainable in a wired communication system.

In existing wireless systems operating according to the AMPS standard, multimedia data transmission may be provided via modems operating on voice channels. Such modems are commonly referred to as Cellular Digital Packet Data (CDPD) modems. Such CDPD modems allow standard voice channels to transmit and receive digitized data. In this fashion, a wireless service subscriber could use a wireless link to transmit and receive multimedia data within the wireless system. However, the bandwidth provided by such CDPD modem typically was less than 9600 bits per second (BPS). Thus, such solution failed to provide enough bandwidth for typical multimedia applications.

Thus there exists a need in the art for a system and associated method of operation that will provide sufficient bandwidth in a wireless communication system for multimedia communications.

SUMMARY OF THE INVENTION

A communication system according to the present invention provides wireless voice and multimedia communications and includes a base station, a plurality of wireless mobile units and a bandwidth allocator. The base station provides wireless coverage throughout a service area and has a bandwidth for providing the wireless coverage. Such bandwidth facilitates both voice communications and multimedia communications. The plurality of wireless mobile units operate within the service area and communicate with the base station to transmit and receive both voice communications and multimedia communications. The bandwidth allocator selectively allocates the bandwidth in response to wireless multimedia communication requirements to achieve a minimum transmission rate for multimedia communications.

The communication system may include a plurality of channels, each having a channel bandwidth with the bandwidth allocator selectively allocating the channels in response to the multimedia communication requirements to achieve the minimum transmission rate. The base station may also include a plurality of data modems, each of the data modems providing a respective portion of the bandwidth, the bandwidth allocator selectively allocating the plurality of data modems of the base station to achieve the minimum transmission rate. Further, at least one of the wireless mobile units may include a plurality of data modems with the bandwidth allocator selectively allocating the data modems of the wireless mobile unit to achieve the minimum transmission rate. In such case, each of the of the plurality of modems may be assigned to a channel.

The system of the present invention may operate according to various communication protocols. In accordance with some communication protocols, the bandwidth allocator may allocate time divisions of the bandwidth to achieve the minimum transmission rate while in other protocols the bandwidth allocator may allocate code divisions of the bandwidth to achieve the minimum transmission rate. Operating in accordance with any of various protocols, the bandwidth allocator may further provide a minimum bandwidth for voice communications.

In one embodiment, the base station may include a base station controller and a plurality of base transceiver stations coupled to the base station controller. In such case, the base station controller includes a wired Internet connection that provides access to the Internet, a public switched telephone system connection and a wireless service interface that facilitates the voice communications and the multimedia communications within the service area. Further, in such case, each base transceiver station provides wireless communications within a respective cell.

The service interface may include a multimedia communication segmentation unit, a multimedia communication assembly unit, a bandwidth negotiation unit and a radio. The multimedia communication segmentation unit segments outgoing multimedia communications for transmission according to allocated bandwidth. The multimedia communication assembly unit reconstructs incoming segmented multimedia communications according to allocated bandwidth. The bandwidth negotiation unit allocates the bandwidth among transmit multimedia communications, receive multimedia communications, transmit voice communications and receive voice communication. Finally, the radio transmits and receives the voice communications and multimedia communications. The service interface may also include a compression unit that compresses transmit voice communications and transmit multimedia communications and a decompression unit that decompresses receive voice communications and receive multimedia communications.

Each of the plurality of wireless mobile units may include a wireless multimedia interface that has a multimedia communication segmentation unit, a multimedia communication assembly unit, a bandwidth negotiation unit and a radio. The multimedia communication segmentation unit segments outgoing multimedia communications for transmission according to allocated bandwidth. The multimedia communication assembly unit reconstructs incoming segmented multimedia communications according to allocated bandwidth. The bandwidth negotiation unit allocates the bandwidth among transmit multimedia communications, receives multimedia communications, transmits voice communications and receives voice communications. Finally, the radio transmits and receives the voice communications and multimedia communications. The multimedia interface may also include a compression unit that compresses transmit voice communications and transmit multimedia communications and a decompression unit that decompresses receive voice communications and receive multimedia communications.

The present invention may include provisions for allocating the bandwidth to establish and maintain a grade of service. Such grade of service may extend to one or more of the mobile units operating in a particular service area. Thus, some of the mobile units, based upon their subscribed levels, receive preference in allocation of bandwidth within the communication system. Further, classes may be established within the communication system to allocate the bandwidth to maintain the grade of service. For example, while a first class may associate with a relatively higher multimedia transmission rate, a second class may associate with a relatively lower multimedia transmission rate. In the example, therefore, those wireless mobile units in the second class would be allocated lesser bandwidth to meet the relatively lower multimedia transmission rate. Further, classes may be established such that the minimum transmission rate is established when bandwidth is available but otherwise the transmission rate is not met.

The communication system may also include management capabilities that indicate the state of the communication system with respect to transmission rate performances. The management capabilities may provide feedback to a system manager, indicating to the manager how well the communication system is performing. Such performance may be measured in a fashion to indicate how the communication system is meeting its grade(s) of service and to indicate how the communication system is providing the classes of service to wireless mobile units operating within the communication system. The system manager may then allocate or deallocate system resources to adjust the available bandwidth in the communication system based upon the information provided.

The present invention also includes a method for accomplishing steps to allocated bandwidth within a communication system to achieve a minimum transmission rate for multimedia communications. The method includes steps for compressing data, segmenting data, allocating bandwidth and such other steps as is required to achieve the minimum transmission rate.

Moreover, other aspects of the present invention will become apparent with further reference to the drawings and specification which follow.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating a communication system for providing wireless voice and multimedia communications in accordance with the present invention;

FIG. **2** is a block diagram illustrating an alternative construction of a communication system for providing wireless voice and multimedia communications according to the present invention;

FIG. **3** is a block diagram illustrating a service interface constructed according to the present invention;

FIGS. **4A** and **4B** are block diagrams illustrating multimedia interface units constructed according to the present invention;

FIG. **5** is a block diagram illustrating a bandwidth management unit that may be incorporated within a service interface or a multimedia interface unit;

FIG. **6** is a diagram illustrating logical connections between a base station and a plurality of mobile units in wireless communication within the communication system according to the present invention, the logical connections representing bandwidth segments assigned according to required transmission rates;

FIG. **7** is a logic diagram illustrating operation of the communication system according to the present invention in initially allocating bandwidth upon registration and in operation corresponding thereto;

FIGS. **8A** and **8B** are logic diagrams illustrating operation of the communication system according to the present invention in the receipt, buffering, and transmission of digital packet data via a wireless link established within the system; and

FIG. **9** is a logic diagram illustrating operation of the communication system in allocating additional bandwidth and deallocating bandwidth to one or more of the mobile terminals during operation of the system.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a communication system **100** constructed according to the present invention. The communication system **100** includes a base station **102** and a plurality of wireless mobile units **104A–104C**. The communication system **100** further includes a bandwidth allocator that may reside wholly within the base station **102** or, as is the case with the embodiment of FIG. **1**, may be distributed among the base station **102** and the plurality of wireless mobile units **104A–104C**.

The base station **102** provides wireless coverage throughout a service area. The base station **102** includes a wireless bandwidth for providing the wireless coverage, the wireless coverage facilitating both voice communications and multimedia communications. Each of the wireless mobile units

104A through 104C operates within the service area and communicates with the base station 102 to transmit and receive both voice communications and multimedia communications. The communication system 100 of the present invention may comprise a cellular system providing coverage to a large number of mobile units over a large area or may provide coverage within a smaller area, serving a relatively smaller number of mobile units. Principles described herein apply equally independent of the relative size of the communication system 100.

In the communication system 100, the bandwidth allocator includes a service interface 106 located in the base station 102 and multimedia interfaces 118A–118C located in the mobile units 104A–104C, respectively. Such service interface 106 and multimedia interfaces 118A–118C operate in cooperation to allocate the available bandwidth within the communication system 100 bandwidth in response to wireless multimedia communication requirements to achieve a minimum transmission rate for the multimedia communications. In this fashion, based upon the transmission requirements between the base station 102 and mobile units 104A–104C, the available wireless bandwidth provided by the base station 102 may be allocated and reallocated as is required to meet the minimum transmission rate for multimedia communications.

The base station 102, in addition to including the service interface 106, also includes host circuitry 110, a wired Internet connection 114, and a public switched telephone network (PSTN) connection 116. The host circuitry 110 couples to the service interface 106 and provides conventional functionality to support operation of the base station 102. Part of the functionality provided by the host circuitry 110 allows communications to be established and maintained between the base station 102 and the Internet via the wired Internet connection 114 and between the base station 102 and the PSTN via the PSTN connection 116. Thus, as compared to base stations otherwise known in the art, the base station 102 according to the present invention includes additional connections for providing the multimedia communications. Connections made for supporting the multimedia communications may be had via the PSTN connection 116 as well as the wired Internet connection 114. Thus, a base station 102 according to the present invention need not necessarily include both the PSTN connection 116 and the wired Internet connection 114.

The service interface 106 includes a bandwidth allocator unit (BWAU) 108 and an antenna connection 112. Such BWAU 108 operates in conjunction with bandwidth allocator units (BWAUs) 120A–120C located within the wireless mobile units 104A–104C to achieve the minimum transmission rate for multimedia communications. As will be further described herein, the BWAU 108 and BWAUs 120A–120C continually allocate, reallocate and deallocate the available wireless bandwidth within the communication system 100 to achieve the minimum multimedia bandwidth requirement. The service interface 106 also includes such known radio circuitry (not shown) as may be required to facilitate wireless communications. The radio circuitry may facilitate various operation in accordance with various wireless protocols within the communication system 100, such protocols including, but not limited to AMPS, NAMPS, GSM, CDMA, TDMA and other protocols.

Each of the wireless mobile units 104A–104C includes additional components. With particular reference to wireless mobile unit 104A, the unit 104A includes terminal circuitry 116A coupled to the multimedia interface 118A to provide standard functionality for the mobile unit 104A. Such standard functionality typically would provide an interface to a user of the mobile unit as well as such other functionality as may be required for the specific application. Antenna 122A connects to at least one radio (not shown) contained within the multimedia interface 118A, the radio facilitating operation consistent with the protocols under which the base station 102 is operating.

The multimedia interface 118A also includes a BWAU 120A that operates in conjunction with the BWAU 108 of the service interface 106 to provide voice and multimedia communication between the wireless mobile unit 104A and the base station 102. Such multimedia interface 118A could comprise a module that plugs into a host unit that contains the terminal circuitry 116A or may be integrally formed with other components of the wireless mobile unit 104A. In this fashion, the multimedia interface 118A could be interchangeable based upon the particular requirements of the system. Wireless mobile units 104B and 104C are constructed similarly to the wireless mobile unit 104A and include additional components such as terminal circuitry 116B–116C, antennas 122B–122C and BWAUs 120B–120C, respectively.

By selectively allocating bandwidth available for multimedia communications among the wireless mobile units 104A–104C, the communication system 100 of the present invention provides and satisfies the particular bandwidth requirements for multimedia communications. Allocation and reallocation of bandwidth according to the present invention considers the varying operational requirements of modern wireless systems and the particular bandwidth limitations placed on such systems. By using available bandwidth, the number of users who may access the base station 102 within the service area is maximized, the relative performance achieved by each mobile unit is maximized and the overall system usage is maximized as well.

The bandwidth allocator may allocate the bandwidth to establish and maintain a grade of service. Such grade of service may extend to one or more of the wireless mobile units 104A–104C operating in the service area. Thus, some of the mobile units, based upon their subscribed grade of service levels, receive preference in the allocation of bandwidth within the communication system. Further, classes may be established within the communication system to allocate the bandwidth to maintain the grade of service at differing minimum transmission rates. For example, a first class may provide a grade of service at a relatively higher multimedia transmission rate while a second class may provide a grade of service with a relatively lower multimedia transmission rate. In the example, therefore, those wireless mobile units in the second class would be allocated lesser bandwidth to meet the relatively lower multimedia transmission rate.

Further, classes of service may be established so that the minimum transmission rate is established when bandwidth is available but otherwise is not met. In such classes, during light loading periods, a wireless mobile unit, 104C for example, may be allocated sufficient bandwidth to meet the minimum transmission rate. However, during heavier loading periods, the wireless mobile unit 104C would receive insufficient bandwidth to meet the minimum transmission rate. Other terminals, 104B for example, may be in a class that has priority in receiving bandwidth during heavy loading periods to meet the minimum transmission rate. As is evident, the bandwidth available within the communication system 100 may be allocated in various ways to provide varying levels of transmission capacity among the mobile units.

The communication system **100** may also include management capabilities that indicate the state of the communication system **100** with respect to transmission rate performances. The management capabilities provide feedback to a system manager, indicating to the manager how well the communication system is performing in meeting the minimum transmission rate. The system manager may then allocate or deallocate system resources to adjust the available bandwidth in the communication system based upon the information provided.

FIG. **2** illustrates another embodiment of a communication system **200** constructed according to the present invention. In contrast to the construction of FIG. **1**, the system **200** has a base station that includes a Base Switching Center (BSC) **202** and a plurality of base transceiver stations (BTSs) **204A–204C**. Each of the BTSs **204A–204C** provides coverage within a respective area while the BTSs **204A–204C** cumulatively provide the wireless coverage throughout the service area.

As illustrated, each of the BTSs **204A–204C** connects to the BSC **202**. The BSC **202** includes a connection to the PSTN **210** and to the Internet **212**. Further, the BSC **202** includes a service interface **206** having a bandwidth allocation unit **208**. The bandwidth allocation unit **208** operates in cooperation with bandwidth allocation units (not shown) located within multimedia interfaces (not shown) contained within a plurality of wireless mobile units operating within the system **200**.

Wireless mobile units operating within the service area of the BSC **202** may include laptop computers **214A** and **214B**, desktop computers **216** and **218** and hand held terminals **220** performing various functions including scanning, measuring and performing transactions among other functions. Each of the wireless mobile units may include a multimedia interface. Such multimedia interface may connect to a respective one of these mobile units via a slot or port. For example, laptop computers **214A** and **214B** commonly include Personal Computer Memory Card International Association (PCMCIA) slots. The wireless multimedia interface for the particular laptop computer **214A** or **214B** could be constructed as a PCMCIA compatible card. Further, with respect to desktop computer **216**, the multimedia interface could be included in a card or a device compatible with SCSI bus. Moreover, with respect to desktop computer **218**, the multimedia interface could comprise a card compatible with a PCI or ISA bus. However, the multimedia interface could simply be integrally constructed other circuitry contained within the particular wireless mobile unit.

FIG. **3** illustrates the particular construction of a service interface **300** that may be included in the base station **102** of FIG. **1** or the BSC **202** of FIG. **2**. The service interface **300** includes compression/decompression and assembly/allocation block **302**, an electronic interface unit (EIU) **314**, modem blocks **304** and **312**, radio blocks **306** and **310**, a coupling block **308** and antenna **306**. The EIU **314** couples the service interface **300** to a host unit **328**. The compression/decompression and assembly/allocation block **302** includes a receive bandwidth assembly unit **316**, a decompression unit **318**, a transmit bandwidth allocation unit **320**, a compression unit **322**, a bandwidth negotiation unit and a buffer **326**.

In the transmission path, the service interface **300** receives multimedia data from the host unit **328** via the EIU **314**. Such data may comprise TCP/IP packets received via an Internet connection **114**, for example, to be transmitted to a wireless mobile unit operating within a service area serviced by a base station within which the service interface **300** resides. During such operation, compression block **322** receives the digitized packet data, buffers such data as required in buffer **326**, compresses the data and then passes the data to the transmit bandwidth allocation block **320**.

The transmit bandwidth allocation block **320** receives such compressed data and negotiates for transmission bandwidth with a receive bandwidth assembly block **316** via bandwidth negotiation unit **324**. Based upon such negotiation via the bandwidth negotiation unit **324**, modems within transmit modem block **312** are allocated for the transmission of the digitized packet data. If more than one transmit modem is allocated for a particular transmit data structure, the transmit bandwidth allocation unit **320** segments data and provides the data to the allocated transmit modem.

Each of the modems within the transmit modem block **312** may include a modem operating according to the cellular digital packet data (CDPD) standards. In such case, the modems of the transmit modem block **312** would comprise CDPD modems, each of which operated upon a particular channel serviced by the base station. Over time, the number of modems in the transmit modem data block **312** allocated for transmissions to a particular mobile unit would vary based upon transmission requirements existing at the particular time.

The transmit radio block **310** receives the output from the transmit modem block **312**, modulates the output from the transmit modem block at one or more appropriate radio frequencies, and passes it through the coupling unit **308** to the antenna **306** for wireless transmission. The transmissions are then received by intended wireless mobile units operating within the service area.

In a receive path, the service interface **300** receives wireless data from the wireless mobile units operating within the service area via antenna **306**. Such wireless data is then passed through the coupling unit **308** to the receive radio unit **306** where it is demodulated and then passed to the receive modem block **304**. Receive modems contained within the receive modem block **304** were previously allocated to channels serviced by a base station within which the service interface **300** resides. Such receive modems contained within the modem block **304** may include CDPD modems, each of which provides a certain bandwidth of the available bandwidth within the service area of the base station.

A receive bandwidth assembly block **316** receives the data from the receive modem block **304** and assembles the data as required. When packets of data, for example TCP/IP packets, are received according to the system of the present invention, such packets may have been segmented prior to their transmission. Upon receipt, the segmented packets pass through a plurality of the receive modems where the segmented packets are demodulated and then passed to the receive bandwidth assembly block **316**. The receive bandwidth assembly block **316** then assembles the segmented packets into correctly assembled data block(s). After the data is correctly assembled, the data is passed to decompression block **318** where it is decompressed and then to the electronics interface unit **314**. From the electronics interface unit **314**, the data is passed to other circuitry contained in the base station.

Thus, the service interface **300** constructed according to the present invention achieves increased performance by allocating multiple communication bandwidth segments for a single logical communication path. In prior art systems, single segments of bandwidth were allocated to particular

wireless units. When the single segments of bandwidth were insufficient, data was buffered as either end of the wireless link until the communication could be obtained. Such buffering of data and waiting for transmission reduced the performance of the link between the two points. Thus, the present invention overcomes such limitation by allocating multiple segments of bandwidth for a single communication path when the requirements of the communication path justify such multiple bandwidth segment allocations.

FIGS. 4A and 4B illustrate constructions of wireless mobile units having multimedia interface units according to the present invention. In particular, FIG. 4A illustrates a particular wireless mobile unit **400** having a multimedia interface unit **402** coupled to a terminal unit **404**. The multimedia interface unit **402** includes compression/decompression circuitry **406**, segmentation/assembly circuitry **408**, a plurality of modems **412**, and a plurality of radios **414**, each of which is connected to one of a plurality of antennas **416**. The components described for the multimedia interface unit **402** work bi-directionally to provide both transmit and receive capability. When a plurality of terminal units **404** are interconnected, such as in a local area network, for example, a single multimedia interface unit **402** may service the plurality of terminal units **404**.

The compression/decompression circuitry **406** provides compression/decompression functions for data passing through the multimedia interface unit **402**. The segmentation/assembly unit **408** includes a buffer **410** and segments and assembles data as is required based upon which of the plurality of modems **412** are dedicated to each transmission or receive operation. For example, significant data transmission is often required by Internet browsers when receiving HTML web pages. HTML web pages may include many kilobytes or megabytes of information. Typically, a request is sent from a user of a terminal unit **404** to receive such HTML files. The transmit request comprises small segments of data while the web pages include large segments of data.

According to the present invention, a single modem of the plurality of modems **412** may submit a request to receive a web page. However, on the receive path, such single modem of the plurality of modems **412** would provide insufficient bandwidth for satisfactory operation. Thus, two or more of the modems of the plurality of modems **412** are allocated for the receipt of the web pages. Once the web pages or other data is received, the modems may be deallocated so that the corresponding bandwidth is available for use by other terminal units. The system of the present invention allows for modification of bandwidths depending upon the particular transmission requirements for each of the wireless mobile units. In this fashion, the systems achieve a minimum transmission rate for multimedia communications within the system.

Each of the modems may be coupled to its own radio of the plurality of radios **412**. In such case, each of the plurality of radios **412** provides access to a channel of a plurality of channels supported by the wireless mobile unit **400**. Each of the radios of the plurality of radios **414** may couple to a respective antenna of the plurality of antennas **416**. However, in another embodiment, each of the plurality of radios **414** may couple to a common antenna **418**. Such coupling and functions are dependent upon the particular protocol(s) supported by the mobile unit within which the multimedia interface unit **402** supports.

FIG. 4B illustrates a wireless mobile unit **450** having multimedia interface unit **452** and a terminal unit **404** coupled to provide multimedia communication support. Components described with reference to FIG. 4B having reference numbers identical to those of the elements described with reference to FIG. 4A have same or similar functionality and will not be further described herein with reference to FIG. 4B.

In contrast to the wireless mobile unit **400** of FIG. 4A, the multimedia interface unit **452** of the wireless mobile unit **450** of FIG. 4B includes a radio **454** that operates according to a CDMA standard or a TDMA standard. Thus, the radio **454** may operate at varying frequencies and with varying chipping sequences depending upon its particular mode of operation. The radio **454** thus includes a code division multiple access block **456** and/or a time division multiple access block **458** to provide such functions. In this construction, antenna **450** connects to radio **454**.

In a CDMA mode, each of the modems **412** may be assigned a particular chipping sequence for operation within the CDMA protocol. Furthermore, in a TDMA mode, each of the modems **412** may be assigned a particular time division within which they can transmit and/or receive data. Thus, while the wireless mobile unit **400** of FIG. 4A included a different radio for each modem, the wireless mobile unit **450** of FIG. 4B uses a common radio for the plurality of modems **412**, with each of the modems assigned a particular code division or time division, whichever the case may be.

FIG. 5 illustrates a particular construction of a bandwidth management unit **500** operable with the system **100** of the present invention. Such bandwidth management unit **500** may be contained within or form a part of a service interface or a multimedia interface, whichever the case may be depending upon the implementation. The bandwidth management unit includes a data assembly unit **502**, decompression unit **504**, bandwidth negotiation/management unit **506**, data distribution unit **508**, and a compression unit **510**.

The compression unit **510** and data distribution unit **508** operate in the transmission of data. In such case, compression unit **510** receives TCP/IP data, for example, and also voice data. The voice compression unit **532** compresses the voice data received by the compression unit **510** while the data compression unit **534** compresses multimedia data received. Typically, voice data received by the compression unit **510** may be compressed at a higher compression factor than the multimedia data received by the compression unit.

The data distribution unit **508** receives the compressed data from the compression unit **510**. The data distribution unit **508** includes a buffering unit **524**, a sequencing unit **526**, an error correction unit **528**, and a timer **530**. The buffering unit **524** buffers data received from the compression unit **510** prior to its transmission as transmit data. The sequencing unit **526** segments the compressed data received from the compression unit **510** as required to distribute transmissions across a plurality of bandwidth segments. For example, as was described with reference to FIGS. 3 and 4A through 4B, compressed data received from the compression unit **510** may be segmented such that it passes over a plurality of transmission bandwidth segments. In such case, the sequencing unit **526** establishes a sequence for such segments so that they may be correctly assembled upon receipt. The error correction unit **528** establishes error correction criteria so that errors in transmission are determined. The timer **530** may be used to time out particular operations as required.

The bandwidth negotiation and management unit **506** operates in conjunction with the data distribution unit **508**

and data assembly unit **504**. The bandwidth negotiation and management unit **506** controls the bandwidth within the particular service area. Such bandwidth negotiation management may be performed on a control channel within the service area. In one embodiment of the present invention, the bandwidth negotiation and management unit **506** is contained within a base station controls all bandwidth allocated within the service area. However, in other situations, each of the wireless mobile units could provide partial control relating to the bandwidth within the service area, such control accomplished with an arbitration scheme.

The data assembly unit **502** and decompression unit **504** operate conversely to the data distribution unit **508** and compression unit **510**, respectively. The data assembly unit **502** includes a buffering unit **512**, a sequencing unit **514**, an error correction unit **516**, and timer **518**. The data assembly unit **502** assembles received data. The buffering unit **512** buffers the received data as is required while the sequencing unit **514** correctly assembles the received as required. The error correction unit **516** detect errors and perform error correction as required. The timer **518** provides a time out indication when such is required. Once the data has been assembled at the data assembly unit **502**, the data is passed to the decompression unit **504**. Such data is decompressed by the voice decompression unit **520** and the data decompression unit **522** as the case may be. The data decompression unit **504** produces the multimedia data, for example in the TCP/IP format and the voice data format.

FIG. **6** is a diagram illustrating logically the relationship between the base station and mobile units **602, 604**, and **606**. As is shown, base station **602** includes two logical connections to wireless mobile unit **602**. These logical connections are referenced as terminal endpoint identifiers (TEIs) **39** and **41**. In such case, unit **39** may serve as a voice connection between base station **600** and wireless mobile unit **602**. Further, terminal endpoint **41** serves as a logical connection for multimedia data transmitted between base station **600** and wireless mobile unit **602**. However, multiple logical connections may be established between the base station **600** and one of the wireless mobile units for each type of data.

While each of these TEIs provides a logical connection, the TEIs providing the multimedia communication link between the base station **600** and one of the mobile units may have a common TCP/IP Internet address. In such cases, the segmentation and desegmentation units contained within the service interfaces and the multimedia interfaces segment the data so that the segmented data is distributed over the multiple TEIs. For example, the connection between base station **600** and the wireless mobile unit **604** includes four logical links, TEI **4** provides a voice link between the wireless mobile unit **604** and the base station while TEIs **27, 17**, and **33** provide multimedia links between the base station **600** and the wireless mobile unit **604**. Thus, three distinct logical paths provide three segments of bandwidth for multimedia communications between the base station **600** and the wireless mobile unit **604**.

Further, as illustrated with respect to wireless mobile unit **606**, TEI **1**, TEI **5** and TEI **56** are established between the base station **600** and wireless mobile unit **606**. In this case, two segments of bandwidth are allocated for multimedia communications, a first segment to TEI **5** and a second segment to TEI **56**. The principles underlying the logical allocation of bandwidth between the base station **600** and the mobile unit **602** through **606** may be carried forth for more than three segments of bandwidth. For example, depending upon the particular mechanisms used, and the segments of bandwidth available, the principles of the present invention may be applied to such level as may be desirable in any system.

FIG. **7** illustrates operation of the system of the present invention in establishing and initially allocating bandwidth to the wireless mobile units operating within the service area. Operation **700** commences at step **701** wherein the base station waits for an access request. Upon such access request at step **701** the base station determines whether the access request from a wireless mobile unit operating within the service area is a valid access at step **702**. If such access is not valid at step **702**, operation returns to step **701**. However, if such access attempt is valid at step **702**, operation proceeds to step **704** wherein the base station determines the nature of the access request. If the access request is identified as a valid voice service request at step **706**, voice bandwidth to the requesting wireless mobile unit is allocated at step **706**.

From step **706**, operation proceeds to step **708** wherein the base station determines whether multimedia interface bandwidth is required for the particular mobile unit. If multimedia interface bandwidth is not required for the particular mobile unit, operation proceeds again to step **722** to provide only voice bandwidth service. Upon completion in providing the voice bandwidth service at step **724**, the system deallocates the bandwidth at step **720** and then returns to step **701**.

If, at step **708**, multimedia interface bandwidth is required for the particular wireless mobile unit, operation proceeds to step **710** wherein the bandwidth allocation unit in the service interface of the base station allocates a default level of multimedia bandwidth. In a typical implementation, the bandwidth available for such multimedia transmissions is split into segments. At step **710** then, one of the segments is allocated to the particular mobile unit. However, in other implementations, no bandwidth is allocated for multimedia communications until such bandwidth is required for operation. In such installations, as much bandwidth as possible would therefore be reserved until use is required.

Next, at step **712** the service interface registers the mobile unit's network address for subsequent communications via network addressing protocols. For example, in one implementation, at step **712**, the service interface would assign an IP address for the particular mobile unit. Thus, when the particular mobile unit attempts to contact other Internet locations, the Internet address for the particular mobile unit will correspond to the base station with the base station forwarding communications to the mobile unit. Then, at step **714**, the service interface generates a cross reference between the network address and the terminal ID or unit for the particular wireless mobile unit. From step **714**, operation proceeds to step **716** wherein the system provides the voice and multimedia bandwidths. Upon completion of service at step **718**, the system deallocates the voice and multimedia bandwidth at step **720** and then proceeds to step **701**.

If at step **704** the system determines that the mobile unit has requested no voice bandwidth, the system then determines whether the mobile unit requires multimedia bandwidth at step **726**. If multimedia bandwidth is not required at step **726**, operation proceeds again to step **701**. However, if multimedia bandwidth is required, operation proceeds to step **728** wherein a default level of multimedia bandwidth is allocated by the system to the mobile unit. Then, at steps **730**, the mobile unit's network address is registered. Subsequently, at step **732**, the system establishes cross references between the network address of the mobile unit and terminal IDs assigned to the mobile unit. As indicated in the FIG. **7**, functions accomplished at steps **728, 730** and **732** are similar to those functions accomplished at steps **710, 712** and **714**, respectively. Next, at step **734**, only multimedia bandwidth is provided to the requesting mobile unit with

such bandwidth continued until an end of service at step **736**. Once an end of service occurs at step **736**, the multimedia bandwidth is deallocated at step **720**.

FIG. **8A** illustrates operation **800** of either the service interface in the base station or a multimedia interface in one of the wireless mobile units in receiving, compressing, segmenting and buffering multimedia data in preparing to transmit the data across a wireless link. At step **802**, the system waits for multimedia data packet. When such packet is received at step **804**, operation proceeds to step **806** wherein the packet is compressed. From step **806** operation proceeds to step **808** wherein the packet data is segmented based upon cross reference information that was established at step **714** of FIG. **7**.

For example, as will be recalled with reference to FIG. **6**, multiple TEIs may be established for multiple paths between wireless mobile units and the base station. Such TEI information is contained within the cross-reference information and the compressed packet data is be segmented based upon the cross reference information so that the transmission of such compressed packet data is distributed across the TEI connections. Finally, at step **810**, the compressed and segmented packet data is buffered in preparation for transmission via respective bandwidth path. From such step, operation returns to step **802** wherein additional multimedia data packets are awaited. Thus, after the completion of the steps in FIG. **8A** packet data received, for example in a TCP/IP format is compressed and segmented so that it may be transmitted over wireless links established.

FIG. **8B** illustrates operation **850** of a service interface or multimedia interface according to the present invention during the transmission of data. At step **852**, operation commences wherein the system waits for multimedia bandwidth availability. Such bandwidths availability may be continuously had in some systems while in other systems, the unit must wait for a particular code sequence or time division wherein the transmission may be accomplished. At such point when bandwidth becomes available at step **854**, the system retrieves the compressed and segmented packet data from the respective buffer at step **856**. As is recalled, at step **808** of FIG. **8A**, the compressed packet data had been segmented according to the particular bandwidth segments available for the transmission. Thus, at step **856**, operation proceeds to retrieve compressed packets that have been segmented and are available for the particular bandwidth segment. Once retrieved at step **856**, the packets are transmitted at step **858** for their intended destination. At their intended destination, the packets are retrieved and when all packets required are available, the packets are reconstructed in the same manner that they had been segmented. After such reconstruction, the packets are decompressed as has been previously described. Thus, after completion of the steps in FIG. **8B**, the receiving location can reconstruct the transmissions and pass them to the terminal unit.

FIG. **9** illustrates operation **900** of the system of the present invention in allocating additional bandwidth and deallocating bandwidth as such allocations and deallocations are required during normal operations. Operation commences at step **902** wherein the bandwidth allocator of the system of the present invention monitors multimedia data flow for each mobile terminal that has been allocated multimedia bandwidth. Such allocations were made at step **710** of FIG. **7**. Steps **904** through **910** illustrate operation of the system when insufficient bandwidth has been established for the mobile terminal. Thus, at step **904**, the system determines that there has been a bandwidth shortfall event for the particular mobile terminal.

Bandwidth shortfall events may be determined when buffer content for the particular mobile terminal exceed a threshold or when buffer content for each particular bandwidth segment exceed a threshold. Alternatively, the system could determine that a bandwidth shortfall occurs when the buffer contents remain at a particular threshold level or above for a duration of time. In such case, the bandwidth segments that have been established are insufficient to reduce the content of the buffer for the particular wireless mobile unit.

From step **904** operation proceeds to step **906** wherein an additional multimedia bandwidth is allocated to the wireless mobile unit whose bandwidth shortfall event has occurred. Such additional allocation could comprise simply an additional segment of bandwidth or additional segments based upon the particular needs determined by the shortfall. For example, if buffers for one wireless mobile unit consistently exceed a threshold by a large margin, at step **906**, more than one bandwidth segment may be allocated in addition to those already existing. However, in another implementation, only an additional bandwidth segment may be allocated.

Then at step **908**, the cross references between the network address and the terminal ID's are updated so that segmented packets are distributed amongst the allocated bandwidth segments. Finally, at step **910**, the system enters a wait cycle for the particular mobile terminal to allow the system to reduce the buffer loading for the particular mobile terminal. Such waiting at step **910** allows the system to settle down to perhaps a steady state operating condition where no more allocations are required.

Steps **912** through **918** are performed by the system in determining when to deallocate segments of multimedia bandwidth for mobile terminals. Such deallocation occurs during operation of a wireless mobile unit that has previously used more bandwidth than is currently needed. At step **912**, the system determines that a bandwidth surplus event for the mobile terminal has occurred. Bandwidth surplus events may occur at such times as buffer contents have been below a threshold for a period of time or when no multimedia communications have occurred between a base station and a particular mobile unit for a period of time. When such bandwidth surplus event for the mobile terminal has been determined at step **912**, operation proceeds to step **914** wherein a segment of multimedia bandwidth is deallocated from the particular mobile terminal. Such deallocation of segments may include a smallest sized segment of a larger sized segment depending upon what had been previously allocated and what triggered the bandwidth surplus event for the mobile terminal **912**. Operation then proceeds to step **916** wherein the cross references between the network address and terminal ID's are established **916**. Then, at step **916**, the system enters a wait cycle for the mobile terminal.

In view of the above detailed description of the present invention and associated drawings, other modifications and variations will now become apparent to those skilled in the art. It should also be apparent that such other modifications and variations may be effected without departing from the spirit and scope of the present invention as set forth in the claims which follow.

We claim:

1. A communication system for providing wireless voice and multimedia communications to a plurality of wireless mobile units, the communication system comprising:

a base station controller including:

a wired Internet connection that provides access to the Internet;

a public switched telephone system connection;

a base station coupled to the base station controller, the base station providing wireless coverage within a cell, the base station having a bandwidth for providing the wireless coverage, the wireless coverage facilitating both voice communications and multimedia communications; and

a wireless service interface coupled to the base station controller and to the base station, the wireless service interface comprising:

a bandwidth allocator that allocates the bandwidth among transmit multimedia communications, receive multimedia communications, transmit voice communications and receive voice communications in response to requirements of the plurality of wireless units;

a multimedia communication segmentation unit that segments outgoing multimedia communications for transmission according to allocated bandwidth; and

a multimedia communication assembly unit that reconstructs incoming segmented multimedia communications according to allocated bandwidth.

2. The communication system of claim 1, the bandwidth including a plurality of channels, each channel having a channel bandwidth, the bandwidth allocator selectively allocating the channels in response to the multimedia communication requirements to achieve a minimum transmission rate.

3. The communication system of claim 1, the base station including a plurality of data modems, each of the data modems providing a respective portion of the bandwidth, the bandwidth allocator selectively allocating the plurality of data modems of the base station to achieve the minimum transmission rate.

4. The communication system of claim 3, at least one of the wireless mobile units including a plurality of data modems, the bandwidth allocator selectively allocating the data modems of the wireless mobile unit to achieve a minimum transmission rate.

5. The communication system of claim 3, the bandwidth comprising a plurality of channels, each of the plurality of modems assigned to a respective channel.

6. The communication system of claim 1, the bandwidth allocator allocating time divisions of the bandwidth to achieve the minimum transmission rate.

7. The communication system of claim 1, the bandwidth allocator allocating code divisions of the bandwidth to achieve the minimum transmission rate.

8. The communication system of claim 1, the bandwidth allocator further providing a minimum bandwidth for voice communications.

9. The communication system of claim 1, wherein at least one of the plurality of wireless mobile units interacts with the bandwidth allocator to receive a minimum transmission rate for multimedia communications.

10. The communication system of claim 9, wherein the bandwidth allocator provides the minimum bandwidth for multimedia communications to maintain a grade of service.

11. The communication system of claim 1, the wireless service interface further comprising:

a compression unit that compresses transmit voice communications and transmit multimedia communications; and

a decompression unit that decompresses receive voice communications and receive multimedia communications.

12. The communication system of claim 1, each of the plurality of wireless mobile units including a wireless multimedia interface comprising:

a multimedia communication segmentation unit that segments outgoing multimedia communications for transmission according to allocated bandwidth;

a multimedia communication assembly unit that reconstructs incoming segmented multimedia communications according to allocated bandwidth;

a bandwidth negotiation unit that allocates the bandwidth among transmit multimedia communications, receive multimedia communications, transmit voice communications and receive voice communications; and

a radio that transmits and receives the voice communications and multimedia communications.

13. The communication system of claim 12, the wireless multimedia interface further comprising:

a compression unit that compresses transmit voice communications and transmit multimedia communications; and

a decompression unit that decompresses receive voice communications and receive multimedia communications.

14. The communication system of claim 1, wherein the bandwidth allocator provides at least one grade of service for multimedia communications.

15. The communication system of claim 14, wherein the bandwidth allocator provides multiple classes of service, each class of service associated with a respective grade of service.

16. The communication system of claim 1, wherein the bandwidth allocator provides performance indications to a user, the performance indications relating the relative performance of the communication system.

17. In a communication system for providing wireless voice and multimedia communications that includes a base station providing a bandwidth of wireless coverage within a service area to a plurality of wireless units operating within the service area, a method of operation comprising the steps of:

receiving bandwidth requirement requests from at least some of the plurality of wireless units, the bandwidth requirement requests including multimedia bandwidth requirements;

allocating the bandwidth among the plurality of mobile units based upon the bandwidth requirement requests, the bandwidth allocated among transmit multimedia communications, receive multimedia communications, transmit voice communications and receive voice communications;

segmenting outgoing multimedia communications for transmission to a wireless unit of the plurality of wireless units according to a respective allocated bandwidth;

transmitting the segmented multimedia communications to the wireless unit using the respective allocated bandwidth;

receiving the segmented multimedia communications at the wireless unit; and

reconstructing the segmented multimedia communications at the wireless unit.

18. The method of claim 17, wherein the bandwidth includes a plurality of channels, each having a channel bandwidth, and the method includes the step of:

selectively allocating the channels in response to the bandwidth requirement requests to achieve a minimum transmission rate.

19. The method of claim 17, further comprising the step of allocating time divisions of the bandwidth to achieve a minimum transmission rate.

20. The method of claim 17, wherein the base station includes a plurality of cellular digital packet data modems with each of the cellular digital packet data modems providing a respective portion of the bandwidth, the method further comprising the step of:

selectively allocating the plurality of cellular digital packet data modems of the base station to achieve a minimum transmission rate.

21. The method of claim 20, wherein at least one of the wireless mobile units includes a plurality of cellular digital packet data modems, the method further comprising the step of:

selectively allocating the cellular digital packet data modems of the wireless mobile units to achieve a minimum transmission rate.

22. The method of claim 17, further comprising the step of providing a minimum bandwidth for voice communications.

23. The method of claim 17, further comprising the step of providing at least one grade of service, with each grade of service corresponding to a minimum transmission rate for multimedia communications within the communication system.

24. The method of claim 23, further comprising the step of providing multiple classes of service, each class of service associated with a respective grade of service.

25. The method of claim 17, further comprising the step of providing performance indications to a user, the performance indications relating the relative performance of the communication system.

26. A wireless unit for operation with a communication system that includes at least one base station that supports wireless multimedia communications within a corresponding cell, the wireless unit comprising:

terminal circuitry;

a radio frequency interface coupled to the terminal circuitry that is capable of wirelessly interfacing with the base station; and

a multimedia interface unit coupled to the terminal circuitry and to the radio frequency interface, the multimedia interface comprising:

a bandwidth negotiation unit that interacts with the base station to obtain an assignment of an allocated bandwidth for transmit multimedia communications, receive multimedia communications, transmit voice communications and receive voice communications;

a multimedia communication segmentation unit that segments outgoing multimedia communications for transmission according to the allocated bandwidth; and

a multimedia communication assembly unit that reconstructs incoming segmented multimedia communications according to the allocated bandwidth.

27. The wireless unit of claim 26, the bandwidth provided by a plurality of channels, each channel having a channel bandwidth, the plurality of the channels allocated in response to the multimedia communication requirements of a plurality of serviced wireless units operating within the corresponding service area to achieve a minimum transmission rate.

28. The wireless unit of claim 26, the bandwidth further allocated along time divisions of the plurality of channels to achieve a minimum transmission rate.

29. The wireless unit of claim 26, the wireless unit including a plurality of cellular digital packet data modems, each of the cellular digital packet data modems servicing a respective portion of the allocated bandwidth, the bandwidth negotiation unit selectively allocating the plurality of cellular digital packet data modems.

30. The wireless unit of claim 29, the bandwidth comprising a plurality of channels, each of which has a channel bandwidth, each of the plurality of digital packet data modems assigned to a respective channel.

31. The wireless unit of claim 26, the bandwidth negotiation unit obtaining sufficient bandwidth to achieve a minimum transmission rate for multimedia communications.

32. The wireless unit of claim 26, the bandwidth negotiation unit obtaining allocations of code divisions of the bandwidth responsive to multimedia communication requirements to achieve a minimum transmission rate.

33. The wireless unit of claim 26, the bandwidth negotiation unit obtaining allocations of time divisions of the bandwidth responsive to multimedia communication requirements to achieve a minimum transmission rate.

34. The wireless unit of claim 26, wherein the base station provides at least one grade of service for multimedia communications.

35. The wireless unit of claim 24, wherein the base station provides multiple classes of service, each class of service associated with a respective grade of service.

36. The wireless unit of claim 26, wherein the bandwidth allocation unit, the performance indications relating the relative performance of the communication system.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,097,733
DATED : August 1, 2000
INVENTOR(S) : Kalyan K. Basu and Carlos A. Molina

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

<u>Claim 3,</u>
Lines 5-6, change "the minimum transmission rate" to -- a minimum transmission rate --.

<u>Claim 6,</u>
Line 3, change "the minimum transmission rate" to -- a minimum transmission rate --.

<u>Claim 7,</u>
Line 3, change "the minimum transmission rate" to -- a minimum transmission rate --.

<u>Claim 10,</u>
Line 2, change "bandwidth" to -- transmission rate --.

<u>Claim 36,</u>
Line 2, change ", the" to -- provides --.

Signed and Sealed this

Ninth Day of April, 2002

Attest:

JAMES E. ROGAN
Director of the United States Patent and Trademark Office

Attesting Officer